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CENTRE FOR GEOPHYSICAL EXPLORATION RESEARCH

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The MAGSAT project in Australia - status report : September 1982

This report summarises the status of work on the MAGSAT project by Australian investigators as of September 1982. Further details may be supplied by the Bureau of Mineral Resources to supplement this report.

MACQUARIE UNIVERSITY/CSIRO ACTIVITIES

1. The first version of the MAGSAT selection and reduction software was completed in July 1981. A major enhancement to support geomagnetic vector data selection and reduction was completed by May 1982. Appendix 1 includes an overview of the major subsystems and their functions. In particular, advice given to us by Dr R.A. Langel (NASA/Goddard Space Flight Center) at a review meeting held at Macquarie University in March 1982, enabled a considerably improved correction for the equatorial electrojet effect.

2. Selection and general reduction of all MAGSAT data over an area between 90°E and 180°E and between 0° and 50°S has been completed. This area includes the Australasian region and surrounding oceans. A brief summary of the reduction steps is given in Appendix 2. Overall nearly 200 profiles across Australia satisfied our criteria for data. We did find that many of the later profiles of the mission were contaminated by noise presumably caused by satellite alignment problems. Table 1 lists profiles selected.

3. Dr B.D. Johnson is presenting the results as obtained through to July 1982 at the 52nd Annual International Meeting of the Society of Exploration Geophysicists to be held in Dallas, Texas, USA, October 17-21. The paper authored by B.D. Johnson and C.N.G. Dampney is entitled "Data Selection Techniques in the Interpretation of MAGSAT Data Over Australia".

4. Preliminary interpretation of the reduced geomagnetic field $\Delta G_{LITHOSPHERE}$ has begun. ΔG_{LITH} is the field inferred to be caused by sources within the lithosphere. During reduction magnetic effects caused by all other causes were eliminated - see Appendix 2. At this stage some possible correlation with major tectonic structures and known continental scale heat flow anomalies has been noted. However more detailed analysis, particularly through 2D and then 3D modelling is necessary to confirm. Significantly, the current (current in the context of geological time) Australian continental edge has little direct correlation with structures inferred from ΔG_{LITH}.

5. Current work underway and planned work over the next 12 months by Drs B.D. Johnson and C.N.G. Dampney of Macquarie University, and Dr Brian Embleton of CSIRO i and will concentrate on interpreting the geomagnetic field caused by the lithosphere in the Australasian and Eastern Indian Ocean regions.

6. Dr B.D. Johnson, co-chief investigator for the MAGSAT project, is to spend 8 months with Dr Bob Langel in the US working on the MAGSAT and allied projects.

BUREAU OF MINERAL RESOURCES ACTIVITIES - possible further report to follow.

In July 1982 BMR began selection and reduction of MAGSAT data measured over Antarctica. By copy of this report to them I am requesting they forward a report concerning their activities to you should they wish to provide further details.

C.N.G. Dampney

C.N.G. Dampney

29 September 1982

TABLE 1
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****
*
* MAGSAT passes accepted over Australian region *
*
****

Pass number	Average long.	Pass number	Average long.	Pass number	Average long.
0374	159	0376	112	0389	168
0390	144	0406	130	0420	163
0421	139	0576	116	0590	149
0591	125	0592	102	0605	158
0606	135	0607	111	0622	121
0637	131	0638	107	0653	116
0730	120	0744	153	0759	163
0760	140	0761	117	0790	160
0791	137	0792	114	0805	170
0807	124	0821	157		
0913	172	0951	163	0952	140
0953	117	1014	135	1015	112
1044	157	1045	130	1046	110
1059	167	1060	144	1061	121
1075	155	1076	131	1106	153
1107	130	1108	106	1138	128
1139	105	1152	162	1153	139
1154	115	1168	150	1169	127
1170	104	1185	115	1214	160
1215	137	1229	170	1230	148
1245	159	1293	123	1294	099
1323	145	1400	155	1401	132
1433	108	1446	166	1448	120
1449	097	1478	143	1781	156
1859	149	1861	103	1874	162
1875	139	1891	128	1892	105
1905	164	1952	156	1953	133
1970	100	1998	173	2000	126
2001	103	2030	153	2032	106
2063	110	2077	147	2078	123
2092	160	2124	141	2155	145
2156	122	2157	099	2217	154
2264	150	2265	127	2266	104
2270	169	2271	146	2281	118
2301	174	2342	152	2350	125
2357	167	2360	098	2364	163
2365	140	2381	131	2490	143
2545	162	2642	096	2924	124

****

A total of 113 passes were selected for final map

These passes are between 0 degrees and 50 degrees South.

APPENDIX 1

Major Subsystems of the MAGSAT data selection and reduction software developed at Macquarie University

*MAGSAT Investigator tape input and conversion. Accepts data in investigator tape format and converts it to internal VAX 11/780 representations. Header and data blocks are checked for various errors and recovery involved as necessary. Table A1.1 summarises errors detected and possible causes.

*MAGSAT Geomagnetic data reduction and selection of satellite traverses. The data is gathered into contiguous arrays holding the various MAGSAT data parameters supplied along a satellite traverse. The data is then selected and reduced according to the selection criteria outlined in Table A1.2. Interactive graphic display of the data enables direct quality control and assessment of the data by the geophysicist.

*GRAPHICS. This provides a colour graphic display of data in many prescribed forms. The geophysicist is able to actively control the data displayed to him during processing. Data can be displayed along profiles, as a map, contoured or in full shaded colour. Options provided the ability to compare and select profiles and then display them in a variety of ways. Ref. Johnson, B.D. & C.N.G. Dampney, 1982. Paper to be presented to the International Annual Meeting of the Society of Exploration Geophysicists, Oct 17-21, 1982 in Dallas.

*GADB: General Array Data Base. This subsystem provides direct storage and retrieval capabilities. Any new data type can be readily added to the data base, and then values stored and retrieved by both profile name and data type name. Reference. Dampney, C.N.G. & B.D. Johnson, 1980. "GADB - A Data Base Facility for Modelling Time/Space Referenced Continua". School of Mathematics & Physics technical report 80-006.

*SCREEN I/O. Initial input by the user of control data into the system requires careful validation. This subsystem performs a comprehensive screen form display and data validation.

TABLE A1.1 - Summary of data errors encountered during processing MAGSAT investigator tapes

Best case

Tape OF8023-1 File 1
Blocks 1 to 2206
Pass # within range 0012 to 1170
No errors

Worst case

Tape OF0513; 14 1 of 2
Blocks 1001 to 3549
Pass # 1735 to 3089, 1205 to 1250

Unnormalized data	Overflow VAX 11/780	Underflow VAX 11/780
4103	14580	12579

Length of Header block errors 28
Length of data block errors 188

The cause of all errors was most likely an error in alignment of physical block to its fields caused by 1 or more dropped bytes.

Summary

Best case error rate - 0%
Worst case error rate - 1%

TABLE A1.2 - Control data accepted by the MAGSAT data processing system

```
What is the name of the MAGSAT file? >MTA0:
Is this a restart? (Y/N) >Y
Number of files to skip >0
Number of blocks to skip >830
Dump of every block? (Y/N) >N
Record of the data errors? (Y/N) >Y
Log processing? (Y/N) >Y
Input from tape? (Y=tape/N=disc) (Y/N) >Y
  Enter tape label >OF8023-1 FILE 1
Enter data into database? (Y/N) >Y
What is the Data Base name? >MS
What is the data dictionary name? >MS
Clear the data base every how many profiles? >4
Check termination of run every how many profiles? >25
What is the time increment tolerance factor? >3.0
Specify selection criteria? (Y/N) >Y
  Select (and chop) by latitude? (Y/N) >Y
    Latitude minimum >-50.
    Latitude maximum >0.
  Select by longitude? (Y/N) >Y
    longitude minimum >90.
    longitude maximum >180.
    Select another longitude strip? (Y/N) >N
  Select by altitude? (Y/N) >Y
    Select bottoming profiles? (Y/N) >Y
      Maximum altitude for bottoming profiles >450.
    Select other profiles? (Y/N) >Y
      Maximum altitude for other profiles >400.
  Select on pass number? (Y/N) >N
  Select on year and day? (Y/N) >N
  Select only profiles with more than a minimum of points (Y/N)
    Enter minimum number of points >30
  Examine and select profiles yourself? (Y/N) >Y
Specify processing parameters? (Y/N) >Y
  Remove external field? (Y/N) >y
  User specified automatic despiking of DMAGTVEC? (Y/N) >y
    Enter DMAGTVEC minimum value >-100
    Enter DMAGTVEC maximum value >100
    Size of smallest spike to remove >5.
Have you made a mistake? (Y/N) >N
```

APPENDIX 2

Summary of MAGSAT data reduction processes

The model

The geomagnetic field data ΔG_{TOTAL} provided on the MAGSAT Investigator tapes is modelled as:

$$\underset{\sim}{\Delta G}_{TOTAL} = \underset{\sim}{\Delta G}_{\substack{EARTH's \\ CORE}} + \underset{\sim}{\Delta G}_{LITHOSPHERE} + \underset{\sim}{\Delta G}_{\substack{EQUATORIAL \\ ELECTROJET}} + \underset{\sim}{\Delta G}_{\substack{OTHER\ INDIVIDUAL \\ EFFECTS}} + \underset{\sim}{\Delta G}_{NOISE}$$

$\underset{\sim}{\Delta G}_{NOISE}$ is modelled along each profile, and its measurement points.

$$\underset{\sim}{\Delta G}_{NOISE}(profile) = DATUM\_ERROR\ (profile) + LEVELLING\_ERROR(profile) + RANDUM\_DATA\_REPRESENTATION\_ERRORS + DATA\_MEASUREMENT\_NOISE + POSITIONING\_ERROR + GEOMAGNETIC\_STORM\_NOISE + OTHER\_IONISPHERIC\_CAUSES$$

Eliminating noise effects

The following processing steps were used to eliminate, or at least substantially decrease noise effects:

1. Representation errors were eliminated by either

   a) data consistency checks, or

   b) spike detection and elimination.

   At the data measurement points where these errors were detected, the value was replaced by the average of its neighbours.

   These errors, which probably included some from other causes, but having the same characteristics, effected about 1% of the data points.

2. Positioning errors were of no consequence.

3. Severe noise caused by geomagnetic storms and other ionispheric causes was eliminated by inspection and total rejection of profiles so effected.

4. In the context of an entire profile, datum-errors and some very small residual levelling errors ($\underset{\sim}{\Delta G}_{\substack{EQUATORIAL \\ ELECTROJET}}$ correction below) were eliminated by referencing against average field values supplied by NASA on a 2 degree grid.

Separating out $\underset{\sim}{\Delta G}_{LITHOSPHERE}$

1. $\underset{\sim}{\Delta G}_{NOISE}$ was substantially decreased by the steps outlined above.

2. $\underset{\sim}{\Delta G}_{EARTH'S\ CORE}$ was calculated from the reference field model values supplied and could thus be eliminated. (At this stage the possibility of components of the reference field sourced within the Earth's Crust has not been completely eliminated).

3. $\underset{\sim}{\Delta G}_{EQUATORIAL\ ELECTROJET}$ The magnetic field caused by the equatorial electrojet was calculated from the equatorial external field values supplied by NASA. The elimination of this field virtually completely resolved large apparent levelling errors in the profiles.

4. $\underset{\sim}{\Delta G}_{OTHER\ IONISPHERIC\ EFFECTS}$ appeared mainly caused within the Australasian region by the Aurora Australis (Southern aurora). This effect was not eliminated, but fortunately only affected the region near Tasmania so far as our area of interest is concerned.

5. It was assumed that no geomagnetic sources are within the Earth's mantle, except possibly sources which are defined for our purposes here as contributing to $\underset{\sim}{\Delta G}_{LITHOSPHERE}$.